ATTEMPT AT A NEW CLASSIFICATION OF THE BOMBYCINE MOTHS.

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For several years past I have been engaged in studies on the life-histories of the members of this group, as well as on the venation and other characters of the adults; the result has been a considerable modification of the classification given in my earlier papers, and that of later authors. I am inclined to regard the Bombyces as a super-family divided into 13 or 14 families. We may begin with what seem to me to be the most generalized forms, those least modified by adaptation to changed surroundings, viz.: the *Notodontidæ*. These seem to have descended from forms more like the Noctuobombyces or Bombycoidea (Thyatiridæ) than any other moths, being similar to them not only in larval, but in adult characters. We will not venture to say that the Notodontians have directly evolved from the Noctuidæ or Noctuina, but they are so similar to them as to be often mistaken for them, in all stages of development; and the Thyatiridæ and Bombyces may have had a common origin from some extinct Noctuid form.

Family 1.—Notodontidæ.

In arranging the genera of *Notodontidæ*, which may be divided into perhaps 6 groups, one should begin first (1) with *Gluphisia*, as the simplest most unmodified form, most like the Noctuina. Then follows *Nadata* and *Lophodonta*. In these genera the larvæ are simple, greenish, with only longitudinal lines, not being ornamented with any spots or humps; the full-fed caterpillars differ but slightly from the freshly hatched young.

2. In *Datana*, the body is simple in shape, but with bright longitudinal bands, and with long hairs. This is succeeded by *Apatelodes*, with its densely hairy body, and its conspicuous pencils.

3. The next step in ornamentation, humps being added, is *Ichthyura*.

4. *Pheosia*, *Notodonta* and *Nerice*, with their allied genera *Edema*, *Dasylophia*, *Schizura*, (*Oedemasia*), *Hyparpax*, and *Janassa* form the typical humped group of the family.

5. This group is succeeded by a large American group represented by *Scirodonta* and *Heterocampa*.

H. marthesia with its long Cerura-like caudal appendages, connects this group, with—

6. The most specialized and modified genus of the family, represented by the species of *Cerura*.

FAMILY 2.—CERATOCAMPIDÆ.

It is not improbable that this family originated from the Notodontians or forms allied to them. It is divisible into two sub-families. The most generalized members of the family are *Dryocampa*, etc., and *Anisota*, the larva of the former being the more simply spined. *Sphingicampa* may be regarded as a transitional genus connecting *Dryocampa* and *Anisota*, with the third group comprising *Eacles* and *Citheronia*. The foregoing genera form a sub-family, which may be named the *Ceratocampinæ*.

The second sub-family we may call the *Agliinæ*, the sole genus being the European *Aglia*. In the venation of the wings *Aglia* shows a most unexpected resemblance to that of *Eacles imperialis*. It will be remembered that the larva of *Aglia* loses at its final molt its spines, and becomes much like a Saturnian of the Telea group. It thus connects the *Ceratocampidæ* with the *Saturniidæ*.

FAMILY 3.—SATURNIIDÆ.

This is a highly modified, and probably quite recent group, whether we take into account the larvæ or the imagines. During the evolution of the group, probably from the Ceratocampidæ, the larvæ, as shown by their life-history, underwent a change in shape, from a rather long and slender form to a thick heavy larva. The moths also underwent a process of degeneration, as seen in the atrophy, total or partial, of the maxillæ, and in the loss of veins in their very large, but weak wings. This family also appears to be a closed type, viz.: none of the higher or more specialized Bombyces appears to have descended from it (unless possibly the Cochliopodidæ.)

The genus *Saturnia* (in its restricted sense), represented by the European *S. carpini* and its allies, and our Pacific Coast *S. mendocino* and *S. galbina*, is the most generalized one of the family. This family may be divided into two sub-families: 1. *Saturniinæ*, 2. *Attacinæ*.

The North American genera of *Attacinæ* may be arranged in the following order: *Platysamia*, *Callosamia*, *Samia*, (*S. cynthia*), *Telea*, *Actias*.

FAMILY 4.—HEMILEUCIDÆ.

At present both on account of its larval and adult characters I am disposed to consider the *Hemileucini* of Grote as most probably of family rank.

The North American genera are *Hyperchiria*, *Hemileuca* and *Pseudohazis*. The exact position of *Coloradia* we have not been able to establish for want of material.

FAMILY 5.—ENDROMIDÆ.

After a somewhat careful examination of the European *Endromis versicolora* I find that it has the head, palpi, and antennæ, as well as the hairy abdomen, much as in *Hemileuca maia*, but the median vein of both wings divides into four branches, and the sub-costal vein of the fore wings divides into five branches, as in *H. maia* and the other Hemileucidæ. The larva has a smooth, sphinx like-body, with oblique bars and a caudal horn. The family appears to form a branch of the Bombycine tree parallel to, but distinct from the Hemileucidæ, and stands above the latter, connecting this group and the Ceratocampidæ and Saturniidæ with the higher families of the Bombyces, in which there are four branches of the median vein, all the families already mentioned, with the Saturniidæ, agreeing with the Notodontidæ in having but three branches.

FAMILY 6.—BOMBYCIDÆ.

The type is *Bombyx mori*; it has three branches of the median vein in each pair of wings.

FAMILY 7.—PLATYPTERYCIDÆ.

In this group also the median vein of each pair of wings have but three branches.

FAMILY 8.—PSYCHIDÆ.

In this aberrant and highly modified group the number of branches of the median vein varies from three (*Perophora*) to four, the true Psychidæ. The group may be divided into two sub-families: the *Lacosominæ*, and the *Psychinæ*. As the females of the Lacosominæ are winged, like the males, they are evidently in this respect, as well as in the larval characters, less modified and more generalized Bombyces than the genuine Psychidæ, and they should for this reason be referred to a distinct sub-family of the group. The three last families form side-branches of the Bombycine phylum, and before passing to the remaining families we shall have to return again to the main trunk, to a point near where the Notodontian branch originated, to consider the next group.

FAMILY 9.—COCHLIOPODIDÆ (Limacodidæ.)

We now come to families in which the median vein of both wings throw off four branches or veinlets. From recent prolonged

studies on the larvæ, especially the freshly hatched ones, as well as the moths, I have been led to consider one of two alternatives. 1. Either the Cochliopodidæ have originated from the Saturniidæ or from forms allied to them; or, 2. Both the Saturniidæ and Cochliopodidæ have descended from a common stem-form, and this perhaps some Notodontian. At all events the systematic position (and in this connection I may say that the larval, pupal, and imaginal characters bear me out) of the group represented by Limacodes and its allies, is very near Saturniidæ, and not far from the Notodontidæ.

I am inclined to believe that the oldest, most generalized, living forms, though at the same time indeed the most highly specialized forms, are the tuberculated larvæ of *Empretia*, *Euclea* and *Adoneta*, as they resemble the larvæ of Saturnians, and in some respects those of the Notodontians. On the other hand the nearly smooth slug-worms, when fully-grown without hairs or even tubercles, such as the larval *Limacodes* and *Heterogenea*, which seem to be the most aberrant and modified, viz.: have become the most adapted to the peculiar mode of life emphasized by the term "slug-worm;" these being caterpillars which have lost by disuse their abdominal legs, the thoracic ones being greatly reduced in size; while by their sluggish disposition, their slug-like slow, gliding mode of progression, and by the peculiar coloration of the larvæ (viz : *Heterogenea*, which mimics the red, swollen spots on the leaves of various trees), we have, as the result of gradual modification brought about by adaptation, perhaps the most strange and bizarre type of Lepidopterous larva in existence.

The succession of genera we should propose is as follows: *Empretia*, *Euclea*, *Parasa*, *Adoneta*, *Phobetron*, *Monoleuca*, *Isa*, *Limacodes*, *Packardia*, *Lithacodia*, *Heterogenea* (including *Tortricidia* and perhaps *Kronca*).

Family 10.—Lasiocampidæ.

Quite contrary to my former opinions and prejudices this family instead of being placed at or near the bottom of the Bombyces, belongs much higher up in the series and should be associated with the Liparidæ rather than with the Ceratocampidæ and allied families; this view being based on a consideration of both larval and imaginal characters.

Beginning with *Clisiocampa*, *Artace*, and *Tolype*, *Heteropacha* connects them with the most highly specialized genus, *Gastropacha*.

The tufted and very hairy larvæ lead to the *Liparidæ*.

Family 11.—Lagoidæ.

We have already attempted to show that *Lagoa* is the type of a distinct family, intermediate between the Cochliopodidæ and the Liparidæ. (Psyche, July, 1892. p. 281).

Family 12.—Liparidæ.

Of this group *Carama* and *Artaxa* may be the more generalized forms, *Dasychira*, *Laria*, *Parorgyia* follow, the most modified and recent form being *Orgyia*, with its wingless females.*

Family 13.—Arctiidæ.

The most generalized form appears to be *Halesidota*, with its tufted larva. The *Lithosiidæ* are certainly very difficult to separate from the Arctians, and after careful consideration of the head and wing characters, I do not feel sure that they should be treated as a separate family, but rather as a sub-family. The chief distinction is in the antennæ, those of the Lithosiidæ being simple. Whether *Nola* should be regarded as the type of a distinct family, or as a sub-family of Lithosiidæ is a matter for debate. Butler places *Lycomorpha* in the Lithosiidæ, but I regard it as a Zygænid.

Family 14.—Zygænidæ.

The next great group is the *Zygænidæ*. Whether it should be regarded as equivalent to the Bombyces as a whole, may well be a matter of doubt. Since some of the simpler forms intergrade with the Lithosians, I am inclined to think that the group is simply a family, and that it should perhaps be associated with the Lithosians and Arctians under the Bombyces, since the larvæ are spinners and hairy, with tufts or pencils of hairs.

At present I think the Zygænidæ should be divided into three sub-families. 1. and lowest, or most generalized, the *Syntomeinæ* (Glaucopinæ); 2. the *Zygænini*; and 3. the *Dioptinæ*, our North American form being *Phryganidia*.

The Zygænidæ as thus circumscribed, are very distinct from the next family, and I am inclined after recent studies on the

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* I have satisfied myself by a study of the venation, etc., that *Varina ornata* Neum. referred to this family in Smith's List, is a Noctuid. Prof. Smith has discovered that it is a synonym of *Acherdoa ferraria* Walk. (See Can. Ent. xxiv. June 1892, p. 135.) Prof. Smith, however, appears not to question its position among the Bombyces.

venation and head-characters to arrange the other higher moths in the following order: *

Family *Agaristidæ*.
" *Castniidæ*.
" *Hepialidæ*.
" *Cossidæ*.
" *Thyridida*.
" *Ægeriidæ*.
" *Sphingidæ*.

The Hepialidæ and Cossidæ appear to be more nearly allied to the Sphingidæ than to the Bombyces, though originally they may have directly descended from the latter group. The two families are closely related.

The three families of Thyridæ, Ægeriidæ and Sphingidæ are closely related.

Finally, it is not improbable that all the moths mentioned in this paper, including also the Rhopalocera, have originated in various ways and at different times from the Bombyces, and perhaps all of them in the first place from the Notodontians; though the Sphingidæ may have evolved from the Ceratocampidæ, or Endromidæ. At present this may be a fairly good working theory to account for the relationship of these families, and at all events the Bombyces are with little doubt the most ancestral and generalized forms of the higher moths, as the Tineina are of Lepidoptera as a whole.

Specimens of *Datana major*, *D. palmii*, *D. contracta*, *D. angusii* and *D. integerrima* have been sent to Mr. C. Palm, from Arkansas, which is a new locality for these species.

A single example of *Harmonia morisonii* Hy. Edw. was taken by Mrs. Slosson at Watkins Glen, N. Y. Hitherto only known from Montana and Missouri.

* It is possible that the Agarstidæ and Castniidæ form a side branch, standing above the Sphinges, and next to the Hesperidæ, Megathymus being the connecting link.